

Complex histories of two lunar zircons as evidenced by their internal structures and U-Pb ages. R.T.Pidgeon¹, A.A. Nemchin¹ and C.Meyer² ¹ Curtin University of Technology, Perth Australia, (r.pidgeon@curtin.edu.au) ² NASA Johnson Space Center, Houston, USA

Introduction: The U-Pb dating of lunar zircon by ion-microprobe provides a robust technique for investigating the timing of lunar events [1,2]. However, we have now identified two cases where the U-Pb systems in a single zircon show more than one age. These complex zircons provide new opportunities for extending our knowledge on the timing of events in the early history of the Moon.

The Pomegranate zircon from Lunar section 73235,82: This consists of numerous angular fragments of sector zoned primary zircon set in a matrix of secondary zircon with a texture that resembles a pseudotachylite (Fig.1). Early ANU SHRIMP analyses on this aggregate were reported by Smith et al. [1] These and additional analyses made at Curtin University yielded an age of 4.31Ga and initial Th/U ratio of 0.21-0.35 for the primary zircon and an age of 4.18Ga and Th/U of 0.04 – 0.17, for the secondary zircon matrix (Fig. 2). The formation of secondary matrix zircon is attributed to an extreme shock event at ca 4.18Ga,

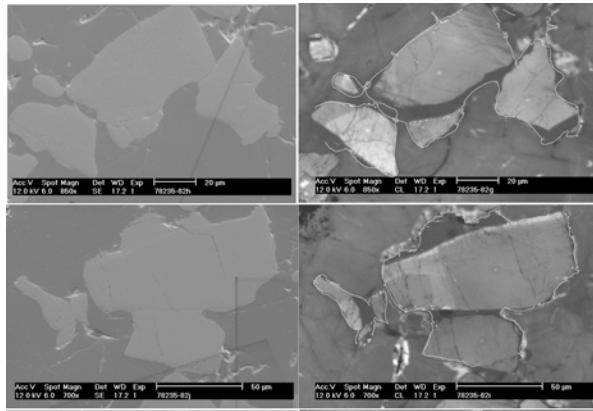


Figure 1. BSE (left) and CL images of parts of the aggregate showing the primary zoned fragments surrounded by matrix zircon.

accompanied by a thermal pulse of at least 1000°C, which caused volatilisation loss of Pb and the addition of U and Yb to the secondary zircon. Raman results suggest that recovery of short range order in radiation damaged crystalline domains occurred at about 3.8Ga, in response to a thermal pulse of under 1000°C, possibly associated with formation of the host breccia during the Serenitatus impact.

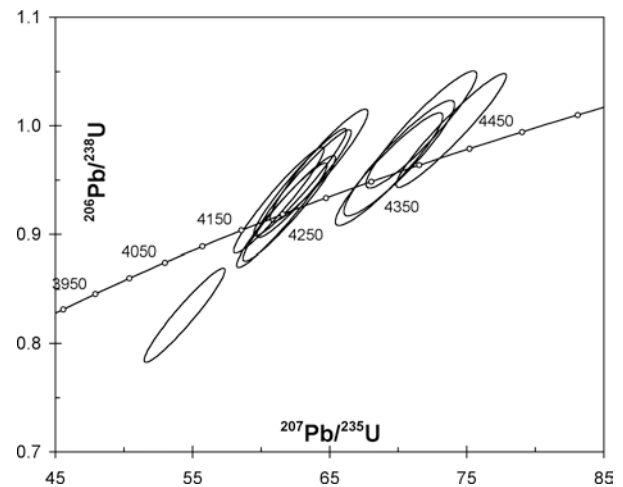


Figure 2. Concordia plot for Curtin SHRIMP measurements on the pomegranate zircon. Two ages are clearly resolved for the primary and matrix zircon.

Arrowhead zircon from section 76295-91: This is a separate “arrowhead- shaped” zircon fragment in the unsorted breccia. It is about 200µ in length and has an irregular to rounded surface with minor re-entrants and a pointed termination and represents the abraded remnant of a larger zircon (Fig.3). The internal structure shown by cathodoluminescence (CL) imagery shows well defined fir-tree and sector zoning in the body of the grain flanked on one side by a narrow, dark CL border (Fig.3). Seven SHRIMP analyses were made on this grain (Fig. 4).

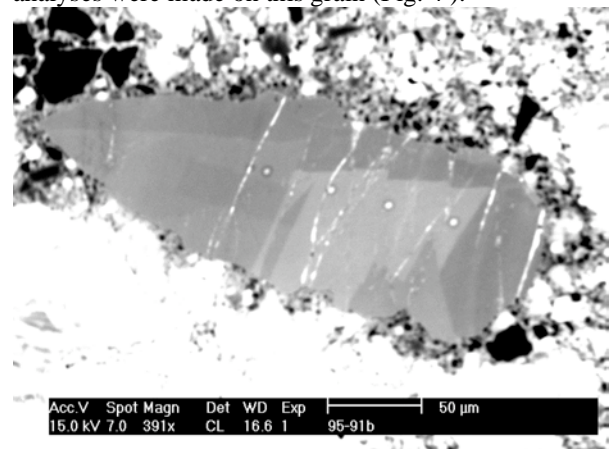


Figure 3 CL image of arrowhead zircon shows sector zoning and the younger border along the top side of the grain.

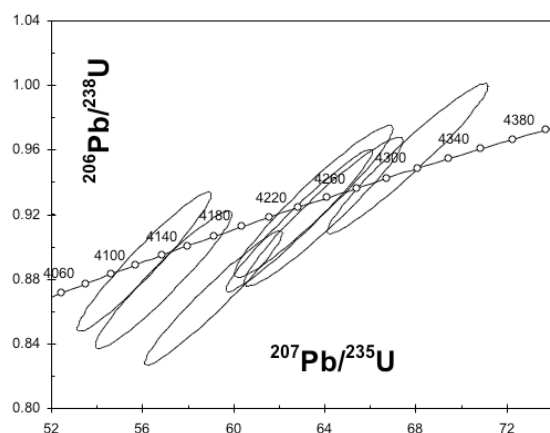


Figure 4. Concordia plot of arrowhead zircon showing the clearly resolved ages of the sector-zoned centre and the dark-CL rim..

Five SHRIMP U-Pb analyses on the main sector zoned part of the zircon fall within a narrow range of $^{207}\text{Pb}/^{206}\text{Pb}$ ages of 4281-4223 Ma. As seen on the Concordia plot (Fig.4) the uncertainties of these analyses overlap. In contrast two analyses on the dark grey (CL) margin, with $^{207}\text{Pb}/^{206}\text{Pb}$ ages of 4106 and 4148 Ma, are significantly younger. We have corrected data with Broken Hill Pb. The contribution of common Pb determined from the ^{204}Pb is very low and is similar in all analyses, so we do not believe the observed age differences can be attributed to an incorrect choice of common Pb correction.

Because the U and Th contents of the central zoned parts and the younger margin are similar and have a consistent Th/U ratio of 0.58-0.68 we interpret the dark CL rim as a reacted selvage rather than new growth and that loss of radiogenic Pb has occurred without any change in the U and Th content. We interpret the age of 4281-4223 Ma as dating the crystallisation of the initial zircon. The age range of 4106-4148 Ma is interpreted as the age of the event producing the reaction rim. The reaction-rim is present on only one side of the grain. Unless the zircon was protected on one side it is likely that the rim would form as a reaction shell completely enclosing the unreacted centre and it is concluded that the present fragment has been broken and abraded a second time to produce its present shape, possibly during the ca 3.8Ga Serenitatus event that formed the host breccia.

Conclusions: We have now found two examples of lunar zircons that record two U-Pb ages. These ages

can be related to morphological features which in turn can be related to lunar events, providing a new opportunity for investigating lunar processes.

References: [1]Smith, J.M., Meyer, C., Compston, W. and Williams, I.S. 1986. LPS XVII, 805-806. [2] Meyer C. Williams I.S. and Compston W. 1996. Meteoritics and Planetary Science 31, 370-387. [3] Nemchin A.A., Pidgeon R.T. and Whitehouse M (in press) Earth Planet. Sci. Lett.